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ALPINE FLOWERS

Alpenblumen ihre Befruchtung durch Insekten und ihre Anpassungen au dieselben. Von Dr. Herman Müller, Oberlehrer an der Realschule I. Ordnung zu Lippstadt. 8vo, 611 pp. (Leipzig: W. Engelmann, 1881.)

THE naturalist who studies animals or plants in a state of nature must often wish that he could test his conclusions experimentally by varying the conditions under which a given set of facts are observed. He wishes that he could change the food of a group of organisms, or the climate to which they were exposed, or that he could diminish the numbers of one sub-group while those of another were increased. As he cannot do this he is obliged to be content with treating the facts within his grasp in the spirit of an experimentalist, by comparing large classes of facts as they occur under different conditions.

The present volume of Dr. Müller's is something more than a descriptive study of the means of fertilisation found among alpine plants, for it is an admirable example of the kind of comparative investigation to which we have alluded, and as such is an extremely valuable contribution to the general science of plant-fertilisation.

It is a difficulty inherent in such inquiries that the observer, not having had a hand in varying the conditions, has to discover exactly in what way the environments differ in his two stations of observation. The most important feature in the environment of a plant considered in relation to fertilisation is the manner in which it is visited by insects. Thus an extensive knowledge of the alpine and lowland insect fauna is a necessary part of Dr. Hermann Müller's inquiry. Nor is it enough to study as an entomologist the relative frequency of bees, flies, butterflies, &c., in the mountains and in the plains; but the observer must discover by long and patient observation the different manner in which these insects visit the flowers in the two regions. The amount of this kind of labour condensed into the volume may be guessed at by looking at the long lists of insect-visits appended to each plant described, or arranged in the statistical tables in the latter part of the book.

The collection of this mass of detail must have tried Dr. Müller's almost unbounded energy and patience to the utmost. Several weeks in each of the last six summers have been devoted to the research; and the record of a single day's work (which we are glad to find was a somewhat exceptional one) will show how well the time at his command has been utilised. On this day, which was spent in the Heuthal on the Bernina, he was surrounded by flowers and insects from 8 a.m. to 4 p.m., during which interval he made notes on the visits of 237 insects, 225 of which were numbered and brought home. Dr. Müller adds that he was continuously spurred to the utmost of his powers by the consciousness that numbers of insects were making unobserved visits behind his back.

Nor has his energy and ingenuity in classifying and tabulating his results been less remarkable, as will be seen by an examination of the twelve tables which are interspersed in the latter part of the book; in these tables the visits of the various orders of insects to various kinds of flowers in different localities are numerically compared.

It is not a little remarkable that the visits of insects, which to the ordinary observer appear so casual and lawless, should be capable of such strict and statistical treatment. But it should be remembered that treatment of this kind is only possible with the large mass of facts which Dr. Müller has collected.

The most striking facts in the book are those connected with the predominance of butterflies in the alpine regions. The changes which occur in the insect fauna as we ascend are briefly that the relative number of Lepidoptera and Diptera (especially the short-trunked flies) increase, while the Hymenoptera and Coleoptera, as well as the other unimportant kinds, diminish in relative number. Thus if we compare the number of different visits made to flowers in the lowlands and the alps,[1] we find the following proportions:—

	Lowlands.	Alps.
Lepidoptera	100	614
Diptera	100	109
Hymenoptera	100	35·5

the number of visits made by each order of insects in the lowlands being taken as 100.

One marked result is that classes of flowers chiefly visited by bees in the lower regions are in the alps much frequented by Lepidoptera. Thus, of a hundred different visits made to Papilionaceæ in the lowlands 73 per cent. are those of Apidæ, 17 per cent. are made by Lepidoptera, so that in the plains they are markedly "bee-flowers." But in the alps only 40 per cent. of the visits made to Papilionaceæ are those of bees, and 56 per cent. are those of Lepidoptera. The same fact was observed in the Labiates and in a number of Composite flowers. The adaptations which alpine flowers exhibit in relation to this preponderance of Lepidoptera form some of the most interesting parts of the book; with some of the facts the readers of NATURE are already familiar, through Dr. Müller's admirable articles on the subject which have appeared in these pages. The principle which underlies these alpine modifications may be illustrated by two sections of the genus Gentian. In the first of these (Cœlanthe) fertilisation is effected by humble-bees creeping inside the corolla. This necessitates so wide a tube that Lepidoptera can steal the nectar without effecting fertilisation. The second section, Cyclostigma, is characteristic of the alpine regions, and the flower has been adapted for fertilisation by Lepidoptera. The passage by which the nectar is reached is so narrow that the proboscis of the butterfly is obliged to touch the anthers, and to effect cross-fertilisation. At the same time the tube in many of the Cyclostigmata is so much lengthened that only such a long proboscis as that of Macroglossus or of Deilephila can reach the nectar. It is probable that the first steps towards the development of closed nectaries were originally serviceable to the plant in protecting the nectar from rain; the flowers being thus rendered more attractive, because the visiting insects had a chance of finding undiluted nectar even after a shower. The lengthening of the corolla tube in the abovementioned section of Gentians which protects the nectar from all but a few long-trunked insects, confers the same kind of advantage on the flower, for it is thus rendered highly attractive to those insects which can alone obtain the honey; and they will fly from flower to flower, passing over the less attractive kinds.

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[1] Alpine as used by Dr. Müller means above the tree-limits.

The genus Rhinanthus has been made especially interesting by Dr. Müller. Rhinanthus is essentially a "bee-flower," but *R. alpinus* has been modified so as to be fertilised by Lepidoptera. The ordinary entrance by which bees visit the flowers of *Rhinanthus cristagalli* is here closed, and a special "butterfly-door," a minute aperture at the tip of the upper lip, has been developed; it is moreover advertised to Lepidoptera by a pair of violet flaps on each side of the entrance. The interesting point about this genus is the existence in it of a species which shows in what manner the flower of *R. alpinus* (fitted for Lepidoptera) may have been developed out of a "bee-flower" such as *R. cristagalli*. This intermediate form (*R. alectorolophus*) possesses a "Lepidoptera-door" like that of *R. alpinus*, but has not closed the bee-door; it is therefore visited by both bees and Lepidoptera and cross-fertilised by both. In spite of our knowledge of this interesting intermediate form, the evolution of *R. alpinus* remains a difficulty. For although it is adapted for the legitimate visits of Lepidoptera only, it is plundered by bees, who break in by the closed bee-door; and these useless or injurious visits are actually more frequent than the advantageous ones of Lepidoptera. It seems impossible to believe that a butterfly-flower could be developed under such circumstances, and the only explanation which Dr. Müller offers requires the assumption of two changes of condition. First, the spread of the bee-fertilised ancestors into regions (such as the Heuthal in the Bernina) where they would be visited exclusively by Lepidoptera, and where the present form of the corolla might be developed. Secondly, we must suppose that the plant has spread into regions where it is visited by bees; or else the plant has remained stationary while bees have invaded its habitat. A similar kind of argument is applied to those flowers, *Polygala alpestris*, various Papilionaceæ, &c., which, though structurally adapted for fertilisation by bees, are, in the alps, chiefly visited by Lepidoptera. They cannot therefore have been developed in their present habitat, but must have spread to the alps from the lowland regions.[1] Dr. Müller compares flowers like *Rhinanthus alpinus*, Gentiana, (Cyclostigma), *Erica carnea*, &c., to air-breathing vertebrates which have been derived from water-breathing ancestors, whose gills have been replaced by special air-breathing structures—the lungs; while *Rhinanthus alectorolophus* corresponds to those intermediate forms which still possess both gills and lungs. We may perhaps, by an inversion of the simile, compare such plants as *Polygala alpestris*, a nearly unmodified bee-flower visited almost exclusively by Lepidoptera, to the Cetacea, which, though actually breathing air, lead almost the life of a fish.

Dr. Müller's treatment of the genera Rhinanthus and Gentiana are instances of the manner in which many other groups are treated. Thus the interesting series of forms exhibited by the Caryophylleæ suggest the possible steps through which bright-coloured flowers adapted for Lepidoptera, such as those of the pinks, have been developed from the pale-coloured scentless flowers with unprotected nectar which are chiefly visited by Diptera.

The present volume gives continual evidence of Dr. Müller's knowledge of the structure and habits of insects. But it does not (and this could not have been expected) contain anything like the valuable study of insects contained in the author's "Befruchtung"—a research of which we take this opportunity of expressing our high admiration, in which we shall be joined by those of our readers who remember the excellent articles by Dr. Müller on insects which appeared in these pages.

In considering the modifications of flowers produced by their relations to insects, we are prepared to find that, for instance, flowers fertilised by bees differ in shape from those visited exclusively by Lepidoptera, but it does not seem *primâ facie* probable that the colours should be characteristic of the two classes. Yet Dr. Müller believes that this is the case, and shows how it may probably be connected with fundamental differences between the lives of bees and butterflies. A bee having to work not only for its own livelihood but also for its nest, is driven to a greater degree of activity than the self-indulgent butterfly. It is therefore important that a bee should work with more method, and thus it happens that bees usually visit one species of flower at a time, instead of passing from species to species and wasting time in the constant change of action. On this account it is obviously an advantage for a bee to be able to distinguish easily a large number of species, thus their unconscious selection has acted in the direction of producing great variety of colouring. It is indeed a remarkable fact that flowers which are visited by short-trunked insects are often characterised by a single colour (usually yellow or white) running through a whole group, whereas closely-related "bee-flowers" are generally varied in colour.

Here then we have a curious chain of cause and effect, beginning with the fact that bees have to provide food for their young, and ending with the varied colours of species of Labiates, Pedicularis, and Trifolium, &c.! If any proof is needed of the correctness of the first link in the argument, it may be found in the curious fact that parasitic or cuckoo bees differ markedly from other bees in their habits,[1] visiting merely those flowers whence they can obtain enough honey for themselves with least trouble and doing it in a dawdling manner which meets with no approval from Dr. Müller.

In the flowers adapted for or chiefly visited by Lepidoptera, red and in a less degree blue are the prevailing tints. There seem to be some grounds for believing that butterflies prefer flowers resembling themselves in tint. Thus in sunshiny weather the orange-yellow flower-heads of Arnica, *Senecio Doronicum*, &c., and the orange-red ones of *Crepis aurea* and *Hieracium aurantiacum* are veritable "Tummelplätze" for yellow-red species of Argynnis and Melitæa. On the other hand the blue Phyteumas which decorate the alpine turf in thousands are especially visited by blue Lepidoptera ("Blues"). It is hard to say whether the butterflies have preferred flowers coloured like themselves, because these tints have been already rendered attractive through sexual selection. Or whether *vice versâ* we may suppose that the colours of their favourite flowers have reappeared as sexual decoration; or lastly, that some physical quality in their organisation makes certain colours attractive wherever they appear.

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[1] This view is, for reasons given in the text, put forward merely as a speculation (p. 559).

[1] P. 522; Dr. Müller adds a caution that the number of observations on this point are perhaps hardly sufficient to warrant a well-grounded conclusion.

To Dr. Hermann Müller belongs the credit of studying not only the means by which cross-fertilisation is effected, but also the means for ensuring cross-fertilisation. He has indeed made this subject peculiarly his own, and has worked it out with valuable and striking results. He has pointed out that flowers which are incapable of self-fertilisation may run great risks of not being fertilised at all. Whereas the flowers in which self-fertilisation is possible are in no danger of becoming sterile, though they may lose the advantage of cross-fertilisation. He has shown that in many plants two forms of flowers exist, one adapted for cross- the other for self-fertilisation. This is the case with *Lysimachia vulgaris* ("Befruchtung," p. 348); when it grows in sunny places where it is freely visited by insects, it has large dark-yellow petals coloured red at the base, conspicuously coloured filaments, and sexual organs arranged so that self-fertilisation can hardly occur; the other form grows in shady ditches, and has a pale yellow corolla and inconspicuous filaments, and the style is so short that self-fertilisation will be sure to take place if no insects visit the flower.

The present volume, though it does not, as far as we are aware, add anything new in principle to the subject of self-fertilisation, contains many illustrations of the correctness of Dr. Müller's views.

We cannot pretend to give, in the short compass of a review article, any fair idea of the richness of Dr. Müller's latest work in new facts and generalisations; we conclude by expressing a hope that it may before long find a translator, or what is a much greater difficulty—a publisher in England.

FRANCIS DARWIN

OUR BOOK SHELF

Lehrbuch der organischen Qualitativen Analyse. Von Dr. Chr. Th. Barfoed. Zweite Lieferung. (Kopenhagen: Andr. Fried. Höst und Sohn, 1881.)

THE first part of this excellent book has already been noticed in these columns. The book is to consist of three parts: the second, which is now published, is characterised by the same completeness and exactness which rendered the earlier part so valuable as a reference book for the laboratory. The present part treats fully of the methods for detecting, in mixtures of varying degrees of complexity, alcohol, ether, chloral, neutral fats, volatile oils, sugar, gum, albumin, &c.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Mr. Butler's "Unconscious Memory"

MR. BUTLER appears to have somewhat misunderstood the aim and scope of my review. He says, "It is true I have attacked Mr. Darwin, but Mr. Romanes has done nothing to show that I was not warranted in doing so." Why should Mr. Butler have expected any such consideration of his case from me? If I were to assault a man in the street I should not expect the policeman to show that I was not warranted in doing so; it would be for me to show that I was so warranted. Therefore, while acting the part of policeman in this matter, my only object was that which I stated, viz. the punishment of an offender, not the refutation of charges which I advisedly characterised as "preposterous, and indeed ridiculous." Truly it would have been a senseless thing had I for a moment imagined that such charges called for anything like a defence of Mr. Darwin. If ever in the world's history there was a book which appealed to all classes of intelligent readers, that book is the "Origin of Species"; and never in the world's history has a book been more studiously criticised or produced a more tremendous change of thought. Can Mr. Butler therefore seriously believe, that after this book has thundered through the world for more than twenty years, it required him to show in what degree it had been anticipated by some of the most celebrated writers within the last two or three generations? Surely common modesty and common sense, were either present, might alike have dictated caution in attributing to all the world an ignorance such as his own, which could be "thrown off the scent of the earlier evolutionists" by anything that Mr. Darwin could say. The publication of the "Origin of Species" could only have had the effect, whether or not its author desired it, of directing renewed attention to the works of "the earlier evolutionists"; and therefore, to put it on no other grounds, it is difficult to imagine a case in which any intentional concealment of the claims of predecessors could well be more impolitic. But the simple fact is that these predecessors had no claims to be concealed, further than those mentioned in my previous communication; that is to say, while they unquestionably and *notoriously* believed in the fact of evolution, they had nothing which deserves to be called a theory of evolution. Therefore, when Mr. Butler asks of the opening passage in the "Origin of Species," "What could . . . . . more distinctly imply that the whole theory of evolution that follows was a growth in Mr. Darwin's own mind?" the answer simply is that this whole theory *was* a growth in Mr. Darwin's own mind. And if Mr. Butler has not judgment enough to distinguish between the scientific value of Mr. Darwin's work and that of "the earlier evolutionists," at least he might pay sufficient deference to the judgment "of all Europe and those most capable of judging" to explain why it is that the work of all the earlier evolutionists proved barren, while the work of Mr. Darwin has produced results unparalleled in the history of thought.

But I am being drawn into a mere waste of time in thus discussing what every one must feel does not admit of discussion. My object in now writing is not to justify Mr. Butler's view that Mr. Darwin requires to be defended from any such nonsensical "attack"; I write in order to withdraw two passages from my review. Mr. Butler says I was wrong in implying that he supposed Mr. Darwin to have entered into a conspiracy with Dr. Krause; he merely supposes Dr. Krause to have acted the part of a "cat's-paw." In this therefore I stand corrected; for while reading "Unconscious Memory" it never occurred to me that Mr. Butler's view was other than I stated. The second passage which I desire to cancel is that which attributes a motive to Mr. Butler in publishing "Evolution, Old and New." He scornfully repudiates the motive which I attributed, and I therefore willingly withdraw the attribution—observing merely that I was induced to advance it because it seemed to present the only rational motive that could have led to the publication of such a book.

Two other allusions to myself may be noticed before I end. Mr. Butler says, "I suppose Mr. Romanes will maintain me to be so unimportant a person that Mr. Darwin has no call to bear in mind the first principles of fair play where I am concerned." To this I answer emphatically, No; but I do maintain that had Mr. Butler been a more important person than he is, he would not have regarded the mere omission of a foot-note of reference to his book, either as an intentional wrong to himself, or as a matter of such grave concern to the public.

Lastly, Mr. Butler says, "I maintain that Mr. Darwin's recent action and that of those who, like Mr. Romanes, defend it, has a lowering effect upon this standard [*i.e.* of good faith and gentlemanly conduct]." I am sure the world of science ought to feel very grateful to Mr. Butler for his kind solicitude on the subject of its morals and gentlemanly feeling. But he has already said in "Unconscious Memory" that he does not look to "ladies and gentlemen of science" for much sympathy, seeing that his case rests on "facts," and that among these "ladies and gentlemen" "familiarity breeds contempt of facts"; and I fear that in this his conclusion will prove better than his argument. For unless some facts and feelings are displayed other than those already exhibited, I cannot think